Learning to drive with cognitive impairment: the experience of young ADHD diagnosed drivers and their parent supervisors

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Abstract

A subset of novice drivers exhibit executive function impairments which may adversely impact on the learn-to-drive period and subsequent driving experience, potentially explaining their overrepresentation in traffic offences and crashes. This paper presents the results of a qualitative analysis of a small series of in-depth semi-structured interviews undertaken individually with affected young drivers (n = 7) and each of their parent supervisors (n = 6). Young drivers were selected on the basis of their ADHD diagnosis, as a sample particularly affected by executive function impairments. Standardised rating scale measures confirmed the currency of the young drivers' ADHD symptoms and executive function impairment. Results are discussed in terms of common experiences of the young affected drivers and those of their parents as supervising drivers of the learn-to-drive process and subsequent driving behaviour. Key themes included difficulties that were related to core executive function impairments symptomatic of ADHD. Themes also included common emotions that the young drivers associated with driving, with particular types of impact on their driving behaviour. Common strategies that were used by both the young driver and their parent during this learning process and their perceived effectiveness are also discussed. Those that were perceived to be most effective tended to focus on reducing the cognitive load for the young driver when introducing new information and skills.

Keywords

Learner Driver, Young Driver, ADHD, Executive Function, Cognitive Impairment, Qualitative

Introduction

Learning to drive is an exciting but challenging experience for young people. This period sets the foundations for a lifetime of driving behaviour and associated crash risks, highlighting its importance as a focus of road safety policy and research. However, it is also a time at which young adults' brains, in areas particularly important for higher order cognitive abilities, are still developing (1). Driving is a complex task requiring the integration of several of these higher-order cognitive functions, such as working memory, sustained attention, attention shifting, interference control, risk perception and response inhibition (both risk taking and the ability to suppress a habitual response in a novel situation), among others (2-3). Collectively, these cognitive abilities are referred to as executive function.

Transport crashes are the leading cause of death among young people aged 15-24 years in Australia, accounting for 32% of all deaths of young people in 2004 (4). Young novice drivers are also over-represented by 2-4 times that of other drivers in transport crashes in both Australia and internationally (5). Developmental impairments in executive function associated with adolescence could potentially contribute to this over-representation, with a recent study finding associations in a combined sample of drivers aged 17-58 years between poorer scores on a self-report measure of executive function, younger age and increased self-reported negative driving behaviours, defined as increased driving violations, mistakes and lapses (6). This study also found some evidence to suggest that younger drivers with poorer executive function are more likely to commit such negative driving behaviours than their better functioning peers. Young novice drivers with conditions characterised by executive function impairments, such as Attention Deficit Hyperactivity Disorder (ADHD), thus potentially face greater difficulties in learning to drive while affected by these cognitive impairments in the context of learning and performing a task that places demands on multiple cognitive abilities.

ADHD is a persistent and highly prevalent disorder with a worldwide prevalence rate of 5.29% (7). It is characterised by symptoms of inattention, impulsivity and hyperactivity (8). These symptoms predispose

to accidents and injuries in everyday life, and recent NSW hospital injury data has revealed young adults diagnosed with ADHD were almost twice more likely to stay in hospital longer (OR = 1.97), suggesting more severe injuries are sustained by this high-risk population (9). Research from North America has shown that adults with ADHD, and adults who were diagnosed with ADHD as children, have consistently poorer traffic histories than their non-ADHD counterparts, particularly speeding, licence suspensions, drink driving and crashes, and perform worse on driving simulators (10,11). A recent meta-analysis of 13 observational studies and experimental pharmacological interventions found an increased driving risk for those with ADHD, reporting an average relative risk of 1.54 (10). More recently, findings from experimental simulation studies have suggested that adults with ADHD are more susceptible to negative performance effects from time-of-day related fatigue (12) and from alcohol intoxication (13) than those without ADHD. In the study by Reimer *et al*. (12) adult drivers with ADHD were more likely than controls to be involved in a crash in a simulator using a monotonous environment, particularly in the morning. Further, the rate of increase in crash involvement from the late afternoon into the evening was greater among drivers with ADHD, despite no differences in self-reported sleep patterns or caffeine use, suggesting that drivers with ADHD possibly became fatigued more quickly than others. In the Weafer *et al.* study (13) drivers with ADHD performed worse on a range of simulated performance measures under alcohol intoxication, particularly in maintaining a constant speed, than did controls, perhaps reflecting an additive effect to baseline (sober) deficits. This study also found that drivers with ADHD, compared with controls, overestimated their driving abilities and underestimated their degree of alcohol intoxication, reflecting a potentially dangerous "positive illusory bias".

Although there is a growing evidence base demonstrating simulated driving performance deficits and poorer traffic histories, there is an absence of Australian research investigating traffic behaviour in this population, and the mechanisms underlying the North American associations are not yet well understood. There is no currently published research that has attempted to understand the driving experience from the young ADHD driver's perspective as a method of identifying factors that may contribute to traffic incidents in this population. Further, there appears to be a complete absence of research focused on the learn-to-drive experience of this population, despite the importance of this period for subsequent driving behaviour.

This study aimed to address this gap through undertaking an exploratory qualitative analysis of learn-to-drive experience and driving incident narratives, obtained through in-depth individual semi-structured interviews of young people with a history of ADHD diagnosis. The main objectives were to gain insight into their perspective, as a population particularly affected by executive function impairments, and identify common themes of cognitive, psychosocial and environmental factors associated with driving difficulties or traffic incidents in this population as well as effective strategies used for improving learning and subsequent driving behaviour.

Methods

Participants

7 young adult drivers with a past diagnosis of ADHD (3 female, 4 males) aged between 16.8 and 26 years were recruited via advertising on relevant ADHD support group websites, newsletters and relevant email lists with participation open to all regions within Australia. 6 matching parent supervisors (3 female, 3 male; aged between 43 and 54 years) of these young drivers were recruited in the same manner. Selection criteria for the young adult sample included being aged between 16.5-26 years, reporting a prior medical diagnosis of ADHD and having at least 6 months prior motor vehicle Australian driving experience. Parents of young adults meeting the criteria were also invited to participate via the same advertisements and emails and through referral by the young adult. Where possible the parent with the most experience supervising the young adult driver was interviewed. One of the young adults declined to invite a parent to participate, resulting in 6 matched pairs together with this young adult's individual interview.

Materials and Procedure

Individual semi-structured interviews designed to run between 45 and 60 minutes were administered to all participants. The author conducted all interviews, either in person or by telephone, which were audio-recorded. Additionally, notes were taken by the author during each interview to enhance the reliability of the data. The items covered a range of contexts and behaviours, beginning with the experience of the

learn-to-drive process, followed by subsequent driving experience. Further specific questions addressed traffic incidents the driver had been involved in, current/typical and past speeding behaviour, other illegal driving behaviours, and driving while under the influence of alcohol, drugs and medicines. None of these questions mentioned their ADHD diagnosis but instead asked participants to reflect and report on their own experience of driving and learning to drive. The final 2 questions of the interview reflected on the ADHD diagnosis by asking participants how they would advise other young drivers with ADHD, and/or their parent supervisors, who were preparing to start learning to drive. Parent interview questions reflected the young adult interview questions but from a parent supervisor perspective (e.g., "Thinking back over the learn-to-drive process, what things were most helpful to your child (any specific strategies)?") and with the addition of supervisor-specific questions (e.g., "What about to you as their parent/trainer (any specific strategies helpful)?").

Following the interview, participants complete a short demographic form and a 10-minute 'short version' of the 'CAARS', the Connors Adult ADHD Rating Scale, consisting of a self-report form for the young adult and 'observer' form for the parent (14). This self-report Likert-scaled measure was designed to assess ADHD symptoms as described in the Diagnostic and Statistical Manual Fourth Edition (8) for individuals aged 18 through 50 years and older. It has adequate reliability and validity, and was included to assess the currency of ADHD symptoms and executive function impairment. The demographic form included questions regarding licence status and traffic infringement history, ADHD diagnosis and medication history, comorbid diagnoses, prior head injury, non-traffic-related injuries and use of substances. At the completion of the session, participants were reimbursed to the value of $20 in cash or a shopping voucher for their time and/or travel expenses.

Data Analysis

Interview audio files were forwarded to a professional transcriber and were transcribed verbatim. These transcripts were analysed one by one in a progressive manner and coded by the author using thematic analysis within a phenomenological approach to understanding the learn-to-drive experience of this sample (15). Themes emerged through careful reading and rereading of each transcript, identified on the basis of recurrence, extensiveness or intensity. Previously coded transcripts were recoded to incorporate the newer themes until no new themes emerged. Young adult' transcripts were analysed first. The parent transcripts' were then analysed beginning with the already identified themes and adding additional themes that did not fit with the existing themes following the same process as before. In addition, parent's transcripts were also compared against their own child's transcript to explore consistency in individual responses. Young adults' self-reported and parent observer reported CAARS data were scored according to the standardised instructions (14).

Results and Discussion

Given the phenomenological nature of this in-depth qualitative analysis, the results are presented conjointly with interpretation and discussion, and to avoid repetition.

Sample Characteristics

The young driver sample consisted of 3 females (1 Provisional and 2 Open licences) and 4 males (3 Learner and 1 Open licences). The parent sample included 3 females and 3 males. One young driver declined to invite a parent to participate, resulting in 1 unmatched case. All 7 young adults' total ADHD Index scores from their CAARS data met criteria for indicating current clinically significant levels of ADHD symptoms (14), providing additional inclusion criteria validity for the ADHD diagnosis. Only 3 of the young adults were currently taking or had recently been taking ADHD medication. Only 2 of these had driving experience while medicated, with both reporting it being beneficial. While these individuals' insights into their perceptions of the effects of ADHD medication on driving behaviour are interesting, they do not form a common experience for the sample and such a discussion is beyond the scope of this paper. All participants self-reported that they predominantly drove in urban road environments, perhaps reflecting the largely email and internet-based advertising used for recruitment. To preserve the anonymity of participants and the confidentiality of their data no further demographic information can be provided.

Key Themes

Four key themes when describing their driving experience emerged from the analysis, which despite open questions not referring at all to the ADHD diagnosis or symptoms (only the final 2 questions of the interview focused on ADHD), tended to relate to key symptoms of ADHD:

1) Problems with attention, memory and focusing on key tasks and distraction problems. There were additional sub-themes in this category around the type of learning strategies employed by both novice drivers and supervisors to minimise this problem and the relationships between these difficulties and with fatigue, and with speed control;
2) Problems with spatial awareness and judging distances;
3) Feeling 'in control' as a consistent emotion and need fulfilled by driving for these young adults, and its impact on driving behaviour;
4) Feeling 'free' and 'independent' by driving.

Problems with attention, memory and focusing on key tasks and distraction problems

Both the young adults and their parent supervisors consistently mentioned problems of the young drivers' attention span and focus and related problems of memory load and being particularly susceptible to distractions, making it the major theme to emerge from the analysis. These could possibly reflect the most dominant clinical features of an ADHD diagnosis (8). Given the importance of these cognitive functions to learning a novel and complex task involving the coordination of several functions (2-3), it is not surprising that they should emerge as contributing to difficulties in learning to drive for young people affected by these symptoms.

"I think he definitely lacks the concentration, most definitely, I've no qualms about that" "He'll come back to talk to me or yell at me or turn at me while he's driving and I can do this and actual fact he's actually lost concentration on the road. So that's one of the majors I've seen…, that umm...he can lose his concentration on the road quite quickly which is a definite worry to me." Parent

"*Focus on the road and not look around. Giving way to the right as well. I had trouble remembering*" Female

"Oh road rules I find it really difficult to remember all the road rules [when driving], because yeah, there's just so many of them and you're trying to concentrate." Male

"Things like having the music on. I am just trying to think of the things that distract him. Too much traffic, particularly when he first started, he really had to be it didn't take much to panic him. So an ambulance coming through totally… he actually went into panic and swerved into somebody else to get out of the way, instead of thinking clearly and all that type of thing. Anything that he thinks is unpredictable. So a bike rider on a pushbike would create almost an instant panic reaction" Parent

Music was mentioned as distracting by most of the sample, at least when talking about learning to drive and all parent supervisors employed a no-music rule during training sessions to avoid this distraction. In contrast, music was also mentioned as actually helping to focus attention most of the time by 1 young female driver and her parent. However she did report adjusting her behaviour in the early mornings to compensate for feeling tired and its effect on her attention by turning the radio off to help her focus , thus suggesting some level of pre-conscious awareness of its distractibility potential. Yet all young drivers holding a provisional or open licence reported that they loved listening to music, loudly, when driving with or without passengers. This suggests these young drivers are aware of the risk but choose to accept it anyway, presumably in favour of the benefits or pleasure they associate with listening to music, and this may not be particularly influenced by peers given the behaviour also occurs when driving alone. This is of particular concern not just because of the increased distraction risk, in an individual already coping with impaired attention, but also in the context of poorer recall of knowledge and skills acquired during the learning phase in a no-music environment. A substantial body of empirical evidence from cognitive psychology has shown reduced recall and performance on cognitive tasks when the learning and recall/performance contexts or environments differ in terms of salient cues such as music (16).

Having problems 'multi-tasking' or 'sequencing' was also raised consistently as an issue by this group.

"*Multi tasking isn't very good for him. So it actually has taken a lot of practice, for example, for him to be able to wind down or wind up the window and stay straight on the road."* Parent

"Just concentrating on several things at once and just keeping it foremost in his mind, you know, what he needs to be looking for, checking his speed, checking behind him. That constant having to be aware and not allowing yourself to jump from one thing to another to actually really being thorough with what you're thinking." Parent

Difficulties maintaining a speed below the limit were also identified by 5 of the young adults or their parents, with some discrepancies in child-parent reports suggesting some lack of awareness by the young driver. These were described in ways such as "*creeping up…anywhere he feels comfortable*" with further descriptions that suggested attention deficits may be contributing. However, 3 of the 7 young drivers also indicated they voluntarily exceeded the speed limits.

Only 1 young driver and his parent did not perceive attention as a particular problem for his driving, though this young driver raised it as an issue for other young adult drivers who have ADHD. He also reported that for him, the driving actually helped him to focus on task because it was so enjoyable:

"Driving for me, I guess, having a concentration disorder, you're more aware of activities that could really take your attention…that grab your attention and keep a hold of it rather than having to force yourself every inch of the way to stay focused on the task. Driving really sucks me in. I enjoy that aspect of it as well…Having that one thing that you're sucked into to concentrating on. Or reading a book. But because driving's mechanical, I'm a little bit more involved. And the senses are more involved." And later: *"driving is fun, very engaging, and very attention grabbing. I find it easier to focus on driving. Because it is exciting so many senses at once, apart from taste. People taste it sometimes. You can taste the petrol. The oil. The mix of it. The rubber or whatever. Yeah, all the dirt."*. Male

However, analysis of this participant's two serious crash narratives (both single vehicle crashes requiring the car to be towed away) suggests that possibly inattention and/or poor impulsive judgement, made worse by fatigue (which he did attribute to one accident, also likely made worse by driving alone late at night), was a likely contributor. Also likely contributing was his speeding or 'cornering', which he believed to be a useful strategy to stay alert when tired by increasing his adrenalin, on wet roads.

"To tell you the truth, if I am exhausted to the point where I am falling asleep at the wheel, I've driven with my head out the window, just to stay awake…But if I'm just very tired it doesn't affect my mechanical performance in a car and it doesn't affect my concentration on the road. It probably affects my ability to make good decisions. Such as don't speed. If I'm tired, sometimes when I'm tired, if I'm that tired, it's better for me to speed and go that little bit faster and have a little bit of adrenalin keeping me alert rather than just cruising. If I was to cruise, possibly I would lose concentration". Male

This is consistent with another sub-theme identified, a perceived particular susceptibility to fatigue effects in reducing their already impaired attention and cognitive abilities. Being alone in the car and feeling comfortable in their surroundings were also mentioned as risk factors for further reducing their attention while driving when tired.

"Yeah, well it was early in the morning, like I said, when I'm not focused at all. I think it was a combination of being first thing in the morning, and because I'm in the car by myself…Yeah. Because I'm just more relaxed." Female, commenting on an at-fault crash.

"*Well it does. I feel it does. Just lack of concentration. It's a can't be botheredness. I'm not sure what the word for that is." "Yeah. Less attentive." "Just sort of glance everywhere, and "Oh yeah, that's alright*". Female, on impact of feeling tired.

"*In lots of ways. Poor judgement and definitely no thinking through."* Parent

"I deal with that constantly. Sometimes". "I guess I lose concentration easily; focus is not as it should be." "Sometimes I am going to merge or change lanes and there's somebody right beside me, that I didn't look before I started to think and merge. Or I might brake too late, not too late but when I should." Female, on impact of feeling tired.

"*Yeah it affects it a whole lot because yeah, obviously you've just got to work harder and harder and that's really annoying to do*." Male, on impact of feeling tired.

The effects described by these young drivers are consistent with the findings of a recent empirical study showing ADHD adult drivers were more affected by time-of-day and monotony-related fatigue effects

than other drivers in terms of numbers of crashes in a simulator (12). However, despite the consistency of tiredness being raised as a problem only the Learner drivers indicated they would avoid driving when tired, with the most frequent response being similar to: "*Just try to stay awake and try to keep focused*." Yet again, as with distraction, in general these young ADHD-diagnosed adults appear to be somewhat aware of the negative effects of tiredness for them personally and consequent driving risks, yet predominantly still choose to accept that risk by driving while tired once driving unsupervised. Further, some of the strategies described by these young drivers to minimise its impact potentially inflate the risk even higher. One example is speeding to increase adrenalin and alertness, which is likely to make it even more difficult to perceive hazards and respond in time. Of course, fatigue-related issues are risks for the general driving population and have been identified as particularly risky for young novice drivers as a group. The introduction of various forms of late-night restrictions into many Australian state government graduated licensing systems may go some way to partly addressing this risk by reducing exposure to such risk environments. However, in Queensland, they apply only as 1) peer passenger restrictions to those holding a "P1" Provisional license and aged under 25 years and 2) as a penalty to particular groups of disqualified and suspended young drivers (see: www.transport.qld.gov.au/youngdrivers). Thus, there is no legislative restriction in Queensland against driving alone at 3am on a Provisional license. It also seems likely that enhanced fatigue-related driving risks, at least for drivers with ADHD, may persist beyond the GLS period and outside the restricted hours, as supported by Reimer et al.'s simulation study (12). As such, possible evidence-based interventions for fatigue-related crash risks outside the scope of legislative restrictions need to be investigated and identified for the ADHD population (and the general driving population). Education programs alone however may be unlikely to be effective given the small sample interviewed were already aware of the detrimental effects of fatigue on their driving behaviour. There is also a more general need for future research to identify effective means of motivating behaviour change in the ADHD population, particularly given their ADHD symptom-related cognitive profile.

Strategies to reduce the impact of inattention, memory load and distraction

All parents and most of the young drivers identified driving/learning-to-drive strategies they had used as helpful that shared a common theme of trying to reduce the impact of attention, memory and distraction problems. This mainly involved providing the novice driver with a clear framework and very clear simple instructions one step at a time, and verbalising each individual task prior to needing to perform it while driving, either by the driver themself or by the parent. Such strategies were uniformly perceived as effective by both parents and their novice driver children, and fit within a context of reducing cognitive load when teaching new knowledge and skills to an individual with cognitive impairment.

"*Basically what we did, prior to starting the drive I would remind him of the things that he would need to concentrate on and then not talk as much while we are actually driving. That seemed to work because me talking to him while he is driving seemed to cause… it's too much for him to take in."* and later *""when we were stopped at traffic lights, for example, I would say, 'Now, we are going to come up to a corner and this is what we are going to do. We are going to stick in this lane but we are going to do a big sweeping bend,' so I would actually pre warn him before he was actually driving and then he would follow it."* Parent

"Well she would talk things out while she's driving, like, if she wasn't sure about something. Which was really helpful. So she'd say, 'Okay I'm going to change lanes now, that kind of thing'. Yeah, like, 'remember that you got to do this, and then you got to do this, okay then that's yes.'" "Well that's what's good with her talking to herself. Because that keeps you focused on what you're doing" Parent

"*My driving instructor was very good, and gave me a good framework to use." On his parent's supervision: "That was good also…was also a very systematic driver" "I think the best thing for people with ADHD is to give them a framework."* Male

"Basically just saying things out loud like for instance, if I was going to change lanes, I would say mirror- indicate- a blind check and that helps me remember." "Yeah just umm saying out loud where I'm going to go so then I just focus, try to focus on where I'm going and what's around me so I don't get confused and maybe take a right turn when I'm supposed to take a left turn. So if I say I want to turn left at these set of lights I will know to turn left." Male

"…and quietly giving him the best logical advice of what he did wrong on a step by step fashion was the best. Well we'd pull over to the side and have a talk at the situation. Not while he's driving whatsoever. He's male remember, only one thing at once". Parent

Other common strategies used and perceived to be effective by both parents and their children was for the supervisor or trainer to remain calm, not to show their nervousness or get upset when the child made a mistake, to use frequent reinforcing comments when the child did something well and calmly reflecting on the aspects requiring improvement after the driving session had finished. The young adults also frequently mentioned practice and experience as being one of the most helpful things for learning to drive or improving their driving.

Early pre-licence exposure to driving

Two of the parents also identified that they believed early pre-licence off-road driving experience helped their children to learn the mechanical aspects of operating a vehicle in a 'safe environment' so that when they then began to learn to drive on-road they could focus on the road environment and driving task without being distracted by the motor coordination aspects. This aspect has an intuitive appeal in the context of reducing cognitive task load for those with cognitive impairments but requires further investigation to evaluate its effectiveness. Further, there is no apparent reason why this type of experience should not be incorporated after first obtaining a Learner licence, thereby after already acquiring road rule knowledge and coinciding with a later stage of cognitive development. It is possible that providing young impulsive individuals with mechanical skills to operate a vehicle in the absence of on-road knowledge and skills could lead to over-confidence. At an age when impulse control and judgement areas of the brain are still underdeveloped (1), this could lead to subsequent difficulties in preventing the unlicensed child from 'taking the car for a spin' on their own, without the parent's knowledge, endangering their own lives and that of other road users. In the current sample, 3 out of the 4 young ADHD diagnosed drivers who had been provided with pre-licence driving experience by parents off-road did in fact drive the family car without the parents knowledge/consent either pre-Learner licence or unsupervised on their Learner licence. Also, the particular environment deemed to be 'safe' is debatable. For example, "off-road" environments present their own risks and hazards. A purpose-built training ground or simulated environment could arguably present a safer environment for the purpose of solely acquiring motor coordination skills associated with driving tasks in the absence of, and prior to gaining experience in, traffic environments and interaction with other road users. A similar proposal was noted recently in a United States Transportation Research Board (TRB) subcommittee's e-circular (17) on the topic of teenage driving as a way to overcome the problem of exposing novice drivers and others to crash risk in order to fulfil their need for gaining driving experience. However, the success of such training environments remains to be evaluated.

Problems with spatial awareness and judging distances/time estimation

All but one of the young adults with ADHD spontaneously described driving-related difficulties with spatial awareness, judging distances and their impact on driving tasks such as changing lanes, merging, negotiating roundabouts and reversing/parking during the learn-to-drive process, and remaining a continuing problem by most. Parent responses were generally very consistent with their child's responses on this aspect. However, neither the young drivers nor their parents reported the use of any particular strategies to try to address the problem, other than obtaining more practice or simply trying to focus more on the task.

"*Estimating the distance when you're pulling out. It's still difficult now. But that was the hardest." "Yeah, and even when you're coming out anywhere and you have to give way. Just pulling out on to a road. You got to make sure that there's enough room to pull out. That's the worst." "And staying in the middle of the road. That's always one."* Female (Also described a serious at-fault crash which appeared to be due to misjudging the distance, or underestimating the time, between her and the car approaching in the opposite direction while making a turn, though other factors such as tiredness and inattention could also be likely contributors).

"*Probably the roundabout…Yeah, road rules…Which way am I going?" "Yeah, which direction to give way to." "Now would be, oh, still the roundabouts. You know, you come onto a roundabout and you are following a road, next minute you have to go straight, which one is which*?" Male

"*Because she was too quick in taking off. I don't know how many times I've thought before, "That's a bit quick, I wouldn't have picked that gap". But yeah sometimes it would have been a really long break and you'd think, "Why would you take that really long break to go in?"* Parent

"*He drifts within his lane…particularly to the left*." Parent

"*I guess also reversing, like how it has to be a different way. A bit confusing at times*." "*I guess just reversing probably, like getting out of tight spots and stuff. Yeah, just realising how much space I have between me and another…..like not another car, but how much space there is when you're actually sitting in the driver's seat and being able to realise….like be aware of it*." Female (Also reported several minor scrapes with parked cars while reversing).

"*Probably keeping close to the middle of the road, I kept leaning over to one side [the left] and yeah that was pretty difficult". "Yeah changing lanes can be a bit difficult actually now that I think about it...Again making, trying to perfect it so that you don't make any mistakes or make sure there are no misjudgements in distance because of.....yeah*." Male

This theme is consistent with a body of evidence showing that individuals diagnosed with ADHD exhibit deficits in time estimation tasks (18) and demonstrate spatial biases/inattention (19-20). Again, such cognitive abilities are also embedded in the complex task of driving, needing to judge the time and distance between vehicles and hazards, particularly in urban traffic environments. While most novice drivers would be expected to be further developing such abilities through driving experience, those with ADHD may be starting with deficits, requiring them to work harder on these aspects and perhaps needing more experience. However, none of the participants raised these problems as an "ADHD problem" when responding to the final interview questions specifically addressing ADHD. This suggests they may not be aware of its association with their symptoms. Alternatively, this might also be a common experience amongst all young drivers (possibly also due to developing brain regions responsible for this type of executive function) and these participants are aware of such difficulties also being common for their non-ADHD diagnosed friends. Future research needs to address whether this is the case and/or if such difficulties are more pronounced in the ADHD population compared with their non-ADHD counterparts consistent with their ADHD symptomatology. Regardless, this study offers some preliminary evidence to highlight this area as an issue warranting further investigation and identification of possible intervention strategies for at least these young drivers with ADHD.

'Feeling in control' and links with driving behaviour

All of the young drivers expressed feeling positive emotions when they drove, including feeling happy, content, relaxed/calm or excited. However the most recently licensed Learner driver also expressed anxiety and pressure not to make mistakes, perhaps reflecting his early stage of learning and his parent's style of supervision. 4 of these 7 young adults with ADHD (including 1 female) consistently described enjoying driving primarily because it gave them a feeling of control, which converged with the parents' responses for two of these.

"*I love it. Just having control of the car." (on why she likes reverse parking).* Later on why she likes driving: *"Having control over something*." Female

"*Yeah, feel much in control."* Male

"*I almost think it gives him control. It's almost like he feels in control or something."* Parent

"*…it kind of makes you feel like you're in control, like you don't really have anyone else driving, it's you, yeah." "Yeah, it actually makes me feel like yeah, I'm in control."* Male

"*In control too I suppose. Controlling a mechanical beast and being able to put it through its paces*." Parent

Further, with the exception of the Learner licence drivers, who were unable to legally drive alone, all of the other young drivers indicated they preferred to drive alone rather than with friends or family. The reasons they provided consistently centred around being able to be more in control of their car and their driving style or route when alone, again highlighting the importance of this feeling to this sample. Most also reported they drove more recklessly or with less attention when driving alone, though passengers talking to them about non-driving relevant matters were also mentioned as distractions. This appears in contrast to a body of road safety literature suggesting increased risk for the general population of young novice drivers in the presence of peer passengers (though the evidence is mixed), which has led to peer passenger restrictions being implemented in many Australian graduated licensing systems including Queensland (see: www.transport.qld.gov.au/youngdrivers). However, it also may reflect a complex relationship between individual driver and peer passenger personalities, interpersonal relationships with each other, road environment and numerous other contextual factors that is not yet understood. Indeed,

investigating how passengers influence teenage driving and crash risk has been recently identified as one the top 5 research priority areas by the US-based TRB Subcommittee on Young Drivers (17).

This desire to feel in control when driving extended to frequent driving styles that tested or validated this feeling for 2 of the male young drivers, through speeding or 'cornering' (taking corners faster than advised for the conditions or speed limit), or in the past racing the vehicle on controlled racing circuits or for one male, 'street racing'. Their parents, while aware of this enjoyment of feeling in control, were generally unaware of their child 'testing the limits' to reinforce these feelings. One female young driver expressed a similar desire to also drive in such ways but only if she was "better protected", citing the example of a race track while wearing protective gear. One of the male young drivers was particularly expressive throughout the interview across a wide variety of topics about his need to feel in control by his driving and the extent to which he validates that feeling on the road. This extended to his choice to use his own car for the practical driving test and for his preference to drive without many passengers as the weight slows him down and makes him feel less in control of the car. For brevity, only a few of these are presented here.

"I like controlling a vehicle and I like a controlling a vehicle well." "…The windows down just enjoying a nice drive through a scenic area, and then occasionally I enjoy a bit of adrenalin." "A little bit faster. Just having to concentrate that little bit more. I guess any driving where you're going a little bit faster than what you'd usually go, anything that's a little bit more than what you're used to is a little bit too, for me, it's not something that scares me, it's something that excites me, so that adrenalin is a good feeling rather than a bad feeling." Male

"And it's that control thing again. You have less control if there's more weight… if I can feel extra weight in the car, it just detracts from the experience a little bit, that little bit more." Male

This same male young driver (both quotes above) had received 6 traffic fines, all speeding-related, and been involved in 2 serious at-fault single vehicle crashes, both involving excessive speed or 'cornering' late at night on wet roads. However, he himself attributed fault mainly on the mechanical aspects of the cars for not 'holding up' with some attribution to his extreme tiredness for poor judgement in choosing that speed for those conditions. Interestingly, his parent only recalled one speeding offence and blamed external factors for both crashes. The young driver did, however, in later questions, reveal that he usually drove much slower and cautiously if he had passengers in the car and if there were other cars on the road.

"*I'm never just driving for myself. If I was just driving for myself, I would have gone over the cliff many years ago. I'd just be flying the whole time*." Male

While such 'testing their vehicle control' behaviours were only reported by 2 male young drivers of the 7 drivers interviewed, it nevertheless may present a worrying association with a common desire by this sample to feel in control. This desire may possibly be particularly salient in this group given the clinical impulse control deficit feature of ADHD. This could perhaps reflect an attempt to regain some sense of control in their life, though further investigation is required to identify the precise underlying mechanisms and whether they are indeed more salient for ADHD vs. non-ADHD affected individuals. This theme also warrants further investigation into how parents can best provide, and young adults can seek, alternative 'safer' ways of fulfilling this need to feel in control.

'Feeling independent' and a sense of freedom by driving.

Each of the young drivers expressed positive comments about driving making them feel free, independent, or a sense of achievement. Parents' beliefs about their child's enjoyment of driving generally converged on this theme also. One parent suggested this feeling was particularly important to her daughter given her impatient and impulsive nature, for example, allowing her not to have to wait for organised or public transport. Impulsive decisions and actions are a clinical feature of ADHD (8) and could potentially contribute to this desire to feel free – which may possibly then be reinforced by driving – to be more salient in the ADHD young adult population. It is likely a salient motivator for these young adults to dedicate the time and cognitive effort to the study and training required to progress to a provisional and open licence despite it being a potentially more challenging feat in the context of cognitive impairments. Two of the parents mentioned imposing conditions on the child that they could not obtain their own vehicle until they gained their provisional licence, thus using this freedom and independence desire as motivation during the early training phase. However, one parent noted it was for

the practical reason of preventing her son from driving unsupervised on his Learner licence, after already hiding the keys to the family cars.

"*Great. It's always a positive experience unless I am stuck in traffic and if I'm limited by the things around me. I like the freedom of driving. Feeling the freedom of when you're driving*." Male

"*Just the feel of it. Just the feel of being free on the road." "That's pretty much it. Just like to be free*." Male

"*There was a little bit of a sense of freedom, I guess, that I could now, I don't know, a step to growing up, getting your licence and being able to drive*." "*…yeah, being you know, having that feeling of being grown up, just turned 17 and yeah*." Female

"*It makes me feel like I can, like I've achieved something, like I can do something that some people can't do. What else? Mmm….yeah I guess it makes me feel like independent from my family. Like I can, I don't have to ask my parents for a lift anywhere unless I was going to drink. But then they can just, I can sort of just do it on my own and …..I don't know*." Female

Divergence in young adult and parent responses: risk-taking and illegal driving

Overall, parents' responses were generally convergent with those of their young adult child's in relation to aspects of the learn-to-drive experience, but less so for post-supervised driving experience, particularly illegal driving behaviours where they were reported by young drivers. In brief, 4 of the 6 young adults described pre-license off-road driving experience (including 2 without their parent's knowledge or consent), unsupervised driving experience on their Learner's Permit (3, all without their parent's knowledge/consent), driving when they thought they may have been over the alcohol limit (2, both had done so quite often, without their parent's knowledge), drug-driving (2 respondents, without parents' knowledge), and intentional speeding (3 young drivers, though with wide variation in the extent and frequency). This is likely due in part to the parent not being in the car with them to know how they are behaving and also consequently not being in a position to directly influence this driving behaviour as a passenger. Of course, with risky and illegal driving behaviours, it is also quite likely the young adults concealed this behaviour from their parents, knowing they would not approve. However, these individual behaviours were only reported by a few young drivers and do not form a common experience for the sample. An exception was mobile phone use, reported by 4 of the 6 young drivers (though in contrast to the other illegal behaviours most parents assumed this occurred). There is a substantial evidence base showing performance deficits associated with mobile phone use while driving leading to increased crash risks in the general driver population (21), leading to legislation in Queensland and other Australian states applicable for both general drivers and extra restrictions for novice drivers (17). However, likely compliance with such legislation remains to be seen with a study of the general driver population in 2 Australian states showing low levels of compliance with such legislation (22). The current sample of young ADHD diagnosed drivers –once away from the parent supervisor passenger – reported frequent mobile use while driving regardless of the legislation. This is of even greater concern given the earlier discussion of this group of young drivers being particularly susceptible to distraction and inattention.

Conclusion and Future Directions

The current sample of young drivers with ADHD reported common types of difficulties in learning to drive and subsequent driving experience that may be related to core ADHD symptoms of deficits in attention/distraction, working memory, time perception and spatial perception. Further, consistent with experimental findings, fatigue was frequently discussed as further impairing these abilities and their driving performance. These present real challenges for both the novice driver and their parent supervisor to overcome and were reflected in problems performing a range of driving tasks, from attending and scanning the environment for hazards, to negotiating lane changes, turns and parking, to controlling and maintaining an appropriate speed. In meeting these challenges, parents and the young ADHD drivers themselves intuitively applied a range of targeted practical learning strategies which essentially shared in common a focus on reducing the cognitive load for the young driver when being presented with new information and skills. In general these were perceived to be highly effective by both groups. These warrant further investigation and evaluation of their effectiveness and usefulness for other young drivers affected by cognitive impairments (which may include all young drivers by virtue of their still developing executive functions) and their parent supervisors. Positive reinforcement of driving in the form of feelings of being in control, free or independent was also a common experience for this sample of young ADHD

diagnosed drivers. These were associated with both positive and negative behaviours and it would be useful for further research to investigate how best to harness these motivations toward the positive, safer end of the continuum for driving and other behaviours. Research is also needed to identify the most effective means of motivating behaviour change in this population, particularly given their ADHD symptom-related cognitive profile.

Finally, the qualitative nature of this study enabled a preliminary insight into the experience of learning to drive for a small group of young drivers particularly affected by a range of executive function impairments. Data obtained from the sample comprising 7 young drivers with ADHD was greatly enhanced by triangulation with 6 of their parents and represents an adequate sample size for the method applied in this context. It has generated some preliminary hypotheses for this specific population which now need to be tested with further research. In particular, the next step in the research program is to quantitatively examine 1) how common these types of experiences are in the ADHD population more generally (in both young driver & adult driver subpopulations) and 2) explore whether they are the same for non-ADHD young drivers and/or adult drivers. Further, if future research does confirm these types of experience as more salient in ADHD and/or general young driver populations it would then be interesting to quantitatively examine the relationship between these experiences with clinical symptom severity (and medication use) and heterogeneity for ADHD and other conditions associated with cognitive impairments, and with the profile of executive function deficits associated with normal development changes in young adults more generally.

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